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Authoring Interactive Fictional Stories in Object-Based Media (OBM)

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ABSTRACT

This paper introduces a generic (i.e. production-independent) framework for OBM storytelling. Aiming to function as a complete end-to-end (from conception to realisation) reference for authoring OBM narrative content, it proposes an integrated model that includes the three essential levels: conceptual, technological and aesthetic. At the conceptual level, we introduce a set of abstractions which provide a unified reference for thinking, describing and analysing interactive narrative structures of OBM content. Their recursive nature make our model stand out in terms of its power of expression. These abstractions have direct one-to-one operational counterparts implemented in our production-independent authoring toolkit – *Cutting Room*. This ensures that any specific story design within the proposed conceptual model is *directly* realisable as an OBM production. This isomorphic relationship between the abstract concepts and their operationalisation is another distinguishing aspect of our overall proposition. We have validated the model at the aesthetic level through the production of the interactive film *What is Love?*, experienced by over 900 people at the media art festival *Mediale 2018* in York, UK, and evaluated through a dedicated questionnaire by 94 of them. As the foundations of OBM storytelling have not yet been established, we trust this paper constitutes a significant milestone in its development.

CCS CONCEPTS

• Human-centered computing • Applied computing

KEYWORDS

Object-Based Media, OBM, Authoring, Storytelling, Narrative, Interactive, Responsive, Non-Linear, Television, Film, Drama

1 Introduction

The ways in which audiences interact with and around television content – the dominant medium for entertainment – has been transformed within the last decade [1, 4]. Viewer choice through time-shifted catch-up services (e.g. iPlayer and All4, in UK) are a continually expanding practice [4]. Other streaming services (e.g. Netflix, Amazon Prime Video, Disney Plus, You Tube TV) add huge momentum to this type of viewing. Audiences have access to the programmes they want, when they want it. The rise in social media has also caused a dramatic shift in the consumption of audio-visual content, particularly with younger audiences [1622]. Audiences interact with and through content. However, more importantly for this research, they also do so whilst watching curated television content, using 'secondary screens' [42, 46]. For example, social media is commonly being used as a discussion platform during live debate programmes [4]. These new behaviours show that *interactive*

experiences are being increasingly demanded in the context of traditional TV viewing. However, to date, interactivity *with* the curated content is only available at the programme, not at a more granular, level and all the other interactions, such as on social media, are more or less *fragmented* from and *have little impact* upon the television programme themselves, which remain predominantly fixed and linear. This is even more apparent with regards to *fictional narrative content*. Except for a very small number of examples (see the 'Related Work' section), there is no fictional narrative content rooted in film and television.

In this context, we are asking the question: could there be an alternative form of curated narrative content, in which the productions themselves are flexible and able to interact with their audiences and the contexts of their viewing? This question has been asked by many, starting with pioneers such as Glorianna Davenport [35] and Janet Murray [38]. Yet, despite a number of successful research outcomes (see the 'Related Work' section), the industry status quo remained the same: linear stories, locked at editing time and immutable at viewing time. We conjecture that the reason for this has not been the form itself, but the inability of the existing technology to support experimentation with and, more importantly, delivery of such content, as well as, consequently, the audiences' lack of understanding, and therefore little demand, of such narrative forms. At a time when neither reasons are valid any longer, we, among others, are revisiting this question. We believe that the only method of properly answering this question and impact practice is through producing robust and comprehensive exemplars, putting them in the hands of the audiences and evaluating their responses. The Object-Based Media paradigm is a consolidated effort in this direction.

Object-Based Media (OBM) is the label created by BBC R&D to denote television content, or, more generally, time-based media content, that is tailored to the viewer's circumstances, preferences and devices, that 'understands' one's viewing habits and are able to flex to fit them [4]. OBM content is made from the same ingredients as the traditional linear content – video and audio clips, graphics, text, etc. – called objects. However, as opposed to traditional content, they are automatically assembled into meaningful experiences to reflect viewer's choices of profiles, rather than being locked into immutable linear programmes in postproduction. The label is new, but the generic concept it denotes has existed under other denominations, including Shape Shifting Media [49]. The former reflects the production perspective, whereas the latter reflects the viewing experience perspective.

The main problem we see in the development of this form, which takes as reference the quality of linear film storytelling and aims to preserve it, but extends the experience space with interaction, is the tight interdependency between form and technology: the development of compelling productions require appropriate authoring tools, while the development of appropriate tools require compelling forms to respond to. Non-linearity opens up a creative space of orders of magnitude higher than its linear counterpart. Authoring multidimensional stories – story worlds – which could be experienced in meaningful and rewarding ways in any linear parsing at viewing time is far more complex than linear authoring (which is a very complex process itself!). We conjecture that, apart from fortuitous cases, sustained and successful creative processes in non-linear storytelling *necessarily* require dedicated tools to support it. Furthermore, the tools have to have a good degree of generality in order to support a sustained process of experimentation and discovery. Otherwise, when examples are implemented in bespoke systems, the production costs remain too prohibitive and the production details buried in low-level code. Dedicated production tools have to provide the concepts with which authors think – i.e. the objects with which interactive story worlds are structured and represented – and have to be able to operationalise them. This is why we trust our paper constitutes a milestone in the development of the OBM paradigm: we are presenting a conceptual framework, a toolkit that operationalises it (*Cutting Room*), and an exemplar production that validates the two (*What is Love?*) – i.e. an overall view of an *end-to-end* research process in authoring OBM fictional narratives.

The questions which drove our research include: how do we conceive and think of non-linear story spaces that could result in meaningful and attractive linear story threads? In particular, what concepts, representations or structures could we employ to transform large stories spaces into comprehensible objects to the human mind? How do we express our thinking into something that the medium can operationalise itself? And how do we make interaction an intrinsic part of the story, rather than being a simple add-on? The first question is addressed through our proposition of a conceptual model, providing a generic and basic set of abstractions for the understanding, design and development of OBM productions. The second question is addressed through Cutting Room, a generic authoring

toolkit able to operationalise our proposed conceptual model. The third question is addressed through findings from the evaluation of *What is Love?*

2 Related Work

2.1 Interactive fictional stories

Although some experiments started already in the early two thousands, there has been only a handful of interactive fictional stories carried by video that reached the audiences with some degree of success. *Switching (2003)* [49] is one of the earliest. Produced for DVD, its narrative 'is structured around a circular system in which everything repeats itself' [49], the viewer being able to jump back and forth in time and location. More akin to narrative games, the story is more emergent rather than told. *Late Fragment (2007)* [31], also for DVD, has a similarly emergent structure, in which the viewer has to piece together the actual story, by navigating, somewhat randomly, through the collection of narrative fragments. *Accidental Lovers (2006/07)* [2] is a production made for TV broadcast, which preserved the *telling* quality of the narrative experience. Broadcast 8 times, it offered, each time, a different narrative experience in response the live audiences' aggregated interaction provided through text messages sent whilst viewing. It had an astute narrative structure which optimised production costs with responsiveness. Some variation was achieved in plot through video content (61 available clips), but a lot more was provided in discourse, through voiceovers (864 available in total) [51]. It is an excellent exemplar illustrating the potential of interactive fictional stories. Although a documentary, we still mention *Inside the Haiti Earthquake (2010)* production [23], as it ensures continuity in time to interactive film and illustrates deployment on another medium, the web. Employing an interaction model reminiscing choices used in narrative games, it suggests its narrative structure is not more than an explicitly represented branching model. *Karen (2015)* [24] takes the experience of interactive video narratives on apps. The story is recounted as a conversation between viewer and Karen over days rather than hours. It did provide a novel experience to what had so far been developed, but, in structure, it remained akin to choices made in narrative games, albeit possibly with a deeper model. *Her Story (2015)* [30], similar in structure with *Late Fragment*, takes the concept to a much higher level of narrative success: published as a game, it offers a more meaningful way of navigating the narrative fragments and a more complex and immersive narrative space. As opposed to *Her Story* and *Karen*, and despite being published as a game, *Late Shift (2017)* [32] is very much grounded in film: it provides a continuous experience, but it allows for viewer choice. The experience has a much stronger story *telling* aspect, than providing the space for a story to *emerge*. Its interactive narrative structures are complex, providing 180 decision points and 8 possible endings. They are mainly binary decision regarding the evolution of the plot, but support to explore the space looking and moving around is also provided. Despite some continuity errors [42], it is another excellent exemplar for interactive fictional stories. *Bandersnatch (2018)* [4] is the best reference for this genre to date, in story as well as in audience reach. The experience is that of a high quality film, but, through the numerous choices given to the viewer, it appears to offer countless meanderings through the story space. This is due to the cunning authoring of the interactive narrative structure: 150 minutes of unique footage is divided in 250 segments which can be juxtaposed in various combinations at viewing time, depending on the choices made by the viewer, which continue to be binary choices regarding the plot. *Bandersnatch* also showcases the potential for interactivity provided through streaming.

We are positioning our own production, *What is Love*, in the same category as *Accidental Lovers*, *Late Shift* and *Bandersnatch*. It is less complex in narrative structure, leads to a shorter experience, and has reached much fewer audiences than all the others. However, it is valuable as it showcases and validates a generic toolkit for structuring interactive films – Cutting Room.

2.2 Research in interactive digital narratives (IDN)

Except for OBM, the research in interactive fictional storytelling with pre-recorded time-based media content has been rather limited in the interactive digital narrative (IDN) community. The field is hugely skewed towards story generation systems (e.g. see reviews in [3, 29]) – i.e. the automatic generation of plot, events, character actions, etc. in the context of narrative games – and the development of theoretical underpinnings for this new form sitting in between story and game [e.g. 38,

26], rather than systems able to recount interactively a pre-determined story with a pre-recorded set of assets. A review of relevant approaches to interactive storytelling with video is provided in [28], which concluded that the vision for developing interactive video centric storytelling has long been more of a promise than reality, but that the opportunities for such developments are ever more present.

2.3 Research in Object-Based Media (OBM)

OBM has been researched and developed in different genres and from different perspectives with regards to both form of expression and technology. Early research reported in the period 2015-2017 developed prototypes illustrating the potential of the form. They included factual programmes, e.g. *Forecaster* [10], giving viewers the ability to select different layers of additional information overlaid on the main immutable audio-video stream, daytime TV, e.g. *CAKE* [17], giving cooking instructions following the viewer's pace of cooking monitored through smart devices, but with the programme pausing between each step of the recipe, and drama, e.g. *Perceptive Media* [22], in which a short dramatic scene was produced able to adjust its visual qualities as well as the way it was edited in response to the viewer's personality profile. They re-ignited the interest in interactive narratives grounded in film and TV and highlighted the need for more generic tools for experimentation, as they were all hard-coded in bespoke software implementations. An attempt to the provision of tools for the production of OBM content was made in *Squeezebox* [6], but their scope was limited to only providing choice for duration of viewing, illustrated with news programmes.

Another significant advancement in OBM has been achieved between by the end of 2018, within a large European R&D project focused on live entertainment [20]. With key case studies in sports, it aimed to allow audiences to personalise their own multi-screen viewing experience, for example by selecting which data to see or which camera perspective to follow, issuing requests from secondary screens synchronised with the main screens [25, 34]. Content (text data, graphics, views) is assembled *at viewing time* on the basis of viewer choices. Its aggregation is made on the basis of pre-authored templates [34], which essentially specify the layout of various possibly chosen objects – regions on the screen – in various possible combinations (e.g. where should the ranking be shown if the viewer chooses to see engine performance parameters). This research exemplified how OBM production could be moved from one-off examples to scalable workflows [18]. However, the focus on the approach was placed on the spatial composition of various streams and data objects on screens, rather than on the narrative aspects realised through the sequencing of content in time.

The narrative angle is the direction that drove our work, with the authoring toolkit Cutting Room developed by the end of 2017 and deployed to productions such as *Living Room of the Future* [7] and *What is Love?* [55]. The field continued to advance, thereafter, with the re-launch of the authoring toolkit StoryFormer for internal BBC use (see the Authoring Tools subsection) by the end of 2018, and deployed to research productions such as *Instagramification* [7], *Discover Your Daemon* [9], and, more significantly, to *Click 1000* [4], which enabled viewers to interact with the programme, skipping ahead to the sections they are really interested in, or going into more detail about the stories that pique their curiosity, thus providing for every viewer a personalised episode of the mainstream *BBC Click* programme.

2.4 Authoring tools

There are only a few tools specifically designed to support the authoring of interactive video narratives, which we are summarising here in the order in which they were developed. The ShapeShifting Media Toolkit, also known as the NM2 Toolkit, resulted from R&D work carried out within a large European collaborative project [21]. Providing a comprehensive set of features for modelling interactive narrative structures, it was used, from 2006, in the authoring and delivery of Accidental Lovers, as well as of some smaller productions [52, 53]. Although no longer in use, as its maintenance stopped in 2010, it has borne a significant influence upon the design of Cutting Room, as, probably, the most comprehensive system to date for modelling interactive narrative structures. Klynt [26] was launched in 2007, and it is now one of the few commercial products for interactive narrative production. It is easy to use and has readily support for various types of media and immediate publishing capabilities on the web. However, with regards to interactive narrative representation, its capabilities are limited to branching structures, being considerably surpassed by Cutting Room at this

end. Twine [50] was launched in 2008 and is one of the main tools used in the development of narrative games, but it has been used, for example, in writing Bandersnatch. It is essentially a tool for structuring the writing of interactive stories, as it does not support time-based audio/video media. In structures, it only supports branching, being thus considerably surpassed by Cutting Room. CtrlMovie [19], completed in 2016, is the system used in the making of Late Shift. It is presented as a generic tool, possible to be used in the production of other interactive films, but no other examples of use beyond Late Shift are provided [19]. Our own Cutting Room, which is presented in this paper, follows in time, having been completed for (experimental) production at the end of 2017. StoryFormer, in its current shape restricted to BBC internal use [12], was completed a year later, in 2018, and was used in the production of BBC Click 1000. There is continuity in concept and visual design between Cutting Room and StoryFormer. StoryFormer is less expressive with regards to modelling interactive narratives, being more or less limited to branching structures, expressed through variables and interactive elements [13]. However, as it is built on the foundations provided by the BBC's digital infrastructure, it illustrates how OBM could be incorporated in broadcasting production workflows. Although a research prototype, Cutting Room is a tool that provides the most comprehensive support for modelling interactive narrative structures, founded in a basic but powerful conceptual model.

2.5 Conceptual models

Conceptual models have been developed, essentially, from two directions: narrative theory (e.g. [43]) and computational approaches to narrative understanding and generation (e.g. [36]). The former normally consist of highly abstract concepts providing versatile analytical models, way distant from the pragmatics of conceiving, designing and producing interactive video-centric fictional narratives. The latter latter normally include computational models, such as logics, being often too technical and thus distant from the authoring process of interactive fictional stories. They are also normally employed in story generation in games, rather than in storytelling with regarded time-bade media. One model that stands out is that provided through the Narrative Structure Language (NSL) [51], dedicated to the authoring of interactive TV and film and the foundation for the ShapeShifting Media toolkit. The core concepts remained the same, but aspects concerning their ability to express story response behaviour – visible mainly through the use of the tool – have been updated in light of the new underlying technologies supporting OBM (e.g. HTML5/JavaScript).

3 Conceptual MODEL & Authoring Toolkit

3.1 Definition and Terminology

Aligned with the more generic definition of OBM, we define an *OBM narrative* as a story recounted essentially through time-based media which can *automatically (re)configure* itself *for each viewing* and *at the time of viewing* to best suit the context in which it is being experienced, taking into account, for example, characteristics of the device (such as screen size, connection bit rate, etc.) and/or of the individual viewing experience (such as time of viewing, age of the viewer, points of interest selected whilst viewing, etc.). An OBM narrative is *responsive* to the contexts in which it is experienced, including choices *explicitly* formulated by its active consumers and/or data *implicitly* available, inferred through other means. We regard OBM narratives as *necessarily* preserving the continuity qualities of traditional film, in meaning as well as in form. In relation to other terms used in related areas, OBM narratives are *interactive*, *responsive*, *non-linear* and providing *personalised* experiences.

3.2 Approach and Architecture

Let us consider the workflow of filmmaking:

Writing: a process that outputs the script
Design: outputs story boards, directorial decisions, pre-visualisations, etc.
Production: filming schedules, directing and shooting; outputs the rashes
Postproduction: colour correction, VFX, editing, etc.; outputs the final cut
Distribution: provides the channels through which the final cut reaches audiences

Our approach to authoring OBM is founded in the editing process of postproduction. In traditional filmmaking, editors assemble the footage onto a linear and immutable time-line. In OBM, the editing process, or at least of part of it, is performed automatically, according to some logic expressed by the creative producers. Obviously this impacts all the other elements of the development and production workflow, as well as the traditional workflow itself. However, what we focused on in our research is writing, postproduction (editing) and distribution platforms.

The logics of most of the interactive films produced so far (see "Related Work") have been directly implemented in low-level programming language – they have been *hard-coded* in algorithms. Such an approach introduces a huge overhead in the overall production process – programmers are required to translate between creative producers and complex programming languages. In our approach, we are exposing the authoring of the logic of the interactive narrative to creative producers and, distinctively from other authoring tools, we do this through a set of dedicated representation structures.

Figure 1 depicts the conceptual architecture we are proposing here for OBM. It emphasises the *representational* aspect of OBM authoring and, so, it details less of the issues related to distribution.

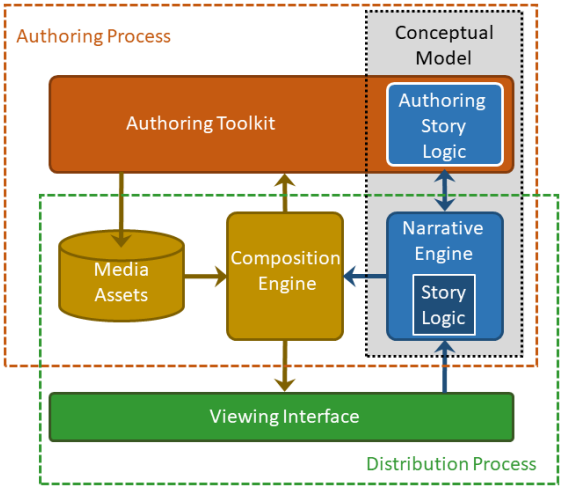

Figure 1: Conceptual OBM Architecture

Authoring and distribution are regarded as separate and sequential processes, but they employ the same major functional components: a *narrative engine*, able to operationalise the logic of each particular story in each particular viewing; a *composition engine*, able to aggregate the media assets into the continuous audio-visual stream, as instructed by the narrative engine; the repository of *media assets*, representing the atomic ingredients for each particular story that can be compiled automatically.

The most important statement made by this architecture is the *factoring out of the story logic* from the other aspects related to its production and distribution. This is captured explicitly as a *distinct object* in the narrative engine. The *story logic* captures all the possible ways in which the specific story can be told, given all the possible data inputs provided by viewers themselves or extracted automatically from the viewing context. The *narrative engine* is able to operationalise each story logic into particular version of the overall story. During each viewing – distribution process – the viewing interface provides various data inputs to the narrative engine. In response, and on the basis of the overall story logic, the narrative engine dynamically compiles the corresponding version of the story. This is made in the form of *playlists* – i.e. *descriptions* of the way the media assets are to be composited. This is an iterative process. The narrative engine goes as far ahead in time in the compilation of the next playlist fragment as is possible given the data inputted up to that point. The compilation pauses where it encounters a decision in the story logic that depends on data not yet provided. As soon as new input is available, a new playlist is computed. Playlists are passed onto the *composition engine* which loads the necessary assets from the media repository and renders them into the corresponding audio-visual stream – the actual narration.

The narrative engine is a production-agnostic component and therefore reusable in the development of any OBM production. It is able to operationalise the *representational structures* of the underlying *conceptual model*. These are the structures used to model the logic of any specific OBM

interactive narrative. They have visual representations in the authoring tool – the *authoring story logic* component. They provide the means to creative producers to build story logics.

3.3 Representation structures

Our model targets the editing process, hence it consists of *conditional aggregation* structures. The *conditions* that are associated with the aggregation structures are made with reference to the standard *properties* of the objects (e.g. duration), the *metadata annotations*, the *interaction variables*, which gradually get bound to specific values at viewing time, and *internal variables*, which capture aspects of the narrative thread being shown (e.g. whether an object has been played or not).

OBM narratives are ultimately made of *atomic objects*. They are direct representations of the media assets, including video and audio clips, elements of text, graphics, data, etc. Each atomic object has a unique reference to an element of content and various metadata annotations, describing its content and narrative functions, possible to be used in the conditions of the story logic. There are also "empty" atomic objects, with no reference to content, which can be used in the *design* of the story structure or in script writing. We are not imposing any restrictions with regards to what can constitute an atom – anything, from a video clip of a few frames long, to a long clip with various data elements burnt into it. The more refined the atomic elements are, the higher the responsiveness of the production is.

Atomic objects are structured into more complex *narrative objects* through conditional aggregation structures. A distinctive characteristic which sets us work apart from others is their *recursive nature*. A narrative object is either atomic or is the result of the aggregation of other objects via one of the pre-defined structures. A complete production is also a narrative object.

Two principles guided our choice of aggregation structures: *expressiveness* – i.e. ability to capture complex logics as required by the development of comprehensive interactive productions; and *meaningfulness to creative producers* – to foster their creative thinking. The fundamental set consists of *conditional fork*, *selection group*, and *conditional layered structure*. The fork is an easy to understand concept, representing branching, whilst the selection group and conditional layered structure build on the notion of *bin* and *layer* in traditional non-linear editing systems.

A *conditional fork* links one origin object with any number of destination objects. Each link has a condition associated with it and, if evaluated to true at viewing time, it represents a potential sequence from source to destination in the playlist. Default rules accompany this structure, stating how to disambiguate, in case more than one link is enabled, or specifying a destination in case none is enabled (to ensure continuity). The *selection group* contains a set of narrative objects, either explicitly enumerated or implicitly, via an expression, and a selection condition which evaluates, at viewing time, to one or more objects from the set. If there is only one, it is the object that will be placed in the playlist when the group is interpreted. If there are more, default rules similar to the fork's are applied. The *conditional layered structure* assembles objects to be played in parallel. It has a leading layer, which constitutes the reference and drives the reasoning, and additional layers which, through associated conditions, are enabled or not at viewing time. In addition, it provides for dynamic synchronisation through *trigger mechanisms* – events on the timeline of a layer can start or stop the playout of another layer. The *interactive object* is a special type of narrative object, designed to support explicit viewer interaction or extraction of data from other devices or platforms. It defines an interaction variable, which becomes bound to a specific value upon viewer or device interaction, or is defaulted to a value if in the absence of an interaction. For viewers, it includes a cue and an acknowledgment, both with timings that can be set at authoring. Reasoning with the story logic and interactive elements at viewing time is, essentially, a constraint solving problem: the narrative engine compiles fragments of playlists after the completion of each interaction object, going as far in the narrative space as possible – i.e. until it reaches a condition that has an unbound interaction variable.

Although targeting postproduction, the structures defined here serve also as design aids in conceptualising the interactive story before production as well as for the script writing process.

3.4 Cutting Room

Cutting Room is the authoring toolkit we developed which implements the representation structures described above (see Figure 2). It provides the following tools: media asset ingestion tool, atomic

narrative object browser, ontology definition, narrative objects inspection tool, which allows also for specific annotations to be made, and, most importantly for this paper, the story logic authoring tool. The latter tool allows for objects to be aggregated in more complex objects. Each structured object can be navigated in and out. As a limitation, the story logic authoring tool allows the viewing of only one type of structure at any one time: all the fork structures at the same level; the content of a selection group; or the layers of a conditional layered object. Figure 2 shows the top layer of the production *What is Love?*, consisting of two sequenced atomic narrative objects, followed by a selection group, then another atomic object forking into four objects possible in the sequence, continuing with two layered structures. In addition, Cutting Room also provides a preview tool and a playlist visualisation tool.

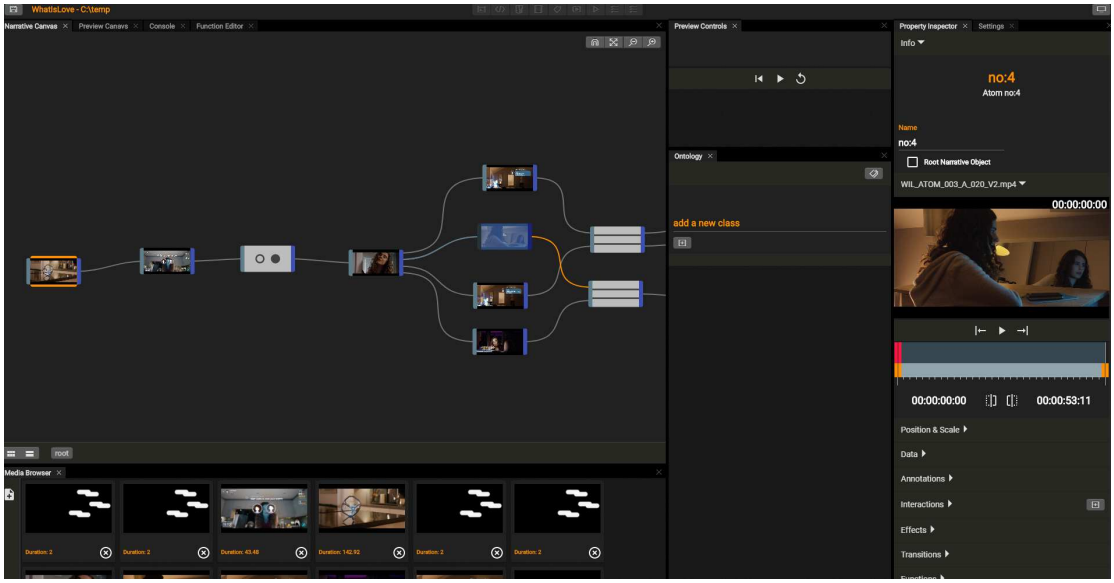

Figure 2: Cutting Room

Cutting Room is implemented in JavaScript, is fully web compatible and supports the creation of OBM narratives which are HTML5 compliant, therefore possible to be viewed in any HTML5 browser. Online delivery of OBM narratives is achieved by *exporting* them as a static, client-side webpage, including two JavaScript libraries: the narrative engine and the composition engine (See Figure 1). The former is implemented by and proprietary to us. The latter is an open source client-side library developed by BBC R&D, called Video Context [10]. It uses HTMLWebGL canvas to render video frames as textures.

Cutting Room was used in the authoring of a number of OBM interactive narratives, including *What is Love?*, which is described below.

4 What is Love?

4.1 Commission

We secured an investment of £20,000 to commission a media production company to develop an OBM interactive film employing the Cutting Room toolkit. We received eight applications in the form of a one page story treatment and a development plan. We shortlisted three and selected Symbolism Media, a production company set up in York, to develop a 20 min long interactive film, *What is Love?* The story promised to provide the richest space for exploring OBM fictional storytelling. The film's director and the producer have previously worked in visual effects for Imaginarium Studios, on large-budget films, such as *Star Wars: The Last Jedi*. Both had significant experience in technology focused film and TV production through VFX, but neither, nor the script writer, had any previous experience of interactive film.

4.2 Story Concept

What Is Love is the story of a triangular relationship between Amelia, a talented dancer, Jack, her partner and a rising star software developer, and Zee, Amelia's devoted AI butler. Their relationship is witnessed and sometimes intruded upon by Amelia's social network followers.

Amelia and Jack live in separate countries and, worse, in different time-zones. But most problematic is that they both live hectic lives and cannot find many occasions to talk directly to each other. So, their communication mainly happens through Zee. Zee is like a most-trusted friend and messenger. However, Zee belongs to Amelia and its mission is to make her life as happy as possible. Amelia sometimes asks Zee to keep things secret from Jack. Zee edits Jack's bouts of anger to reduce their impact upon Amelia. It has a sharp logical intelligence. It is capable of mimicking people's appearance, including Jack and Amelia's, morphing its voice and face into anyone's. Delicate voice nuances and subtle facial expressions are all within its control. But when it comes to reading and responding to emotion, Zee is still naïve and needs our help.

Zee is also Amelia's "secretary" in interacting with her rich social network. Amelia sometimes asks Zee to share too intimate details with her followers. The boundaries between reality and fiction, happiness and ignorance, intimacy and exposure are challenged. Zee faces these challenges. How would AI be able to mediate such situations? The AI is the veil, as, ultimately, *What is Love?* challenges us, the viewers.

The ultimate shape of the story is determined by our interactions. We are asked by Zee to help its decisions. When we do, we mark points of interest, about which we have a view. The story then exploits this, by challenging us with pro, and counter, arguments. The denouement, then, reveals our interventions and sheds a stronger critical light upon our views. The narrative intent is that, through interaction, we build a closer emotional connection to the issues to which we react, allowing for deeper messages to be conveyed.

Non-linearity was conjectured to be required for two reasons. One was to enhance the sense of urgency of the viewers' interventions, particularly when less activity is detected, by increasing the dramatic tension through faster cutting and the choice of higher tension scenes. The other one was to identify issues with which the viewer gets emotionally connected – signalled through interaction – and subsequently to explore them more in depth by following the respective story threads.

4.3 Interaction concept

The interaction mechanisms are versions of social media interaction. One is standard, allowing the active viewer to like or dislike posts by Amelia or her followers, but mainly suggestions by Zee. This is used when a faster reaction is required. The other mode allows more versatility with regards to the expression of an emotional response to a situation or a reaction by Zee and involves a series of emojis varying from loving to hating. In the first part of the story, as the viewers become familiar with the interaction mechanism, they don't carry much meaning. Later, they become more meaningful in influencing the development of the story. Also, initially, the cues for interaction are quite explicit and visible, but after a few interactions, they become more discrete.

4.4 OBM Implementation in Cutting Room

What is Love was fully implemented in Cutting Room. We do not have the space to provide a detailed description of the story logic expressed in our model, but will illustrate it with two examples.

Like interactions are used in points in the film in which Amelia shares posts on her social media feed. This structure is implemented as a layered object consisting of three layers: the video showing Amelia (including audio); a text box containing the post; and an interaction object giving the cue for input to the viewer, defining a variable that stores the input ("like" or "no reaction"), and an animated picture containing a series of hearts cascading up the screen on transparent background, shown as a response to viewer interaction. Each post is triggered by Amelia giving a waving hand gesture and saying the word "share!". In turn, after a second, this triggers the interactive object, cueing the viewer for interaction. The like interactions are provided in a sequence, allowing the harvesting of viewers' points/topics of interest. These would inform the choice of the subsequent chapters of the story. Despite the design and the logic readily expressed in Cutting Room, the choice of subsequent chapters was not implemented in *What is Love?* due to production costs.

Emoji interactions. It has a similar OBM structure to the "like" interactions with regards to eliciting viewer input, as it harvests point of interest associated with emotional responses. There is a sequence of such interactions which lead to a group structure which develops the themes, in accordance to the viewer's choices. The group's selection condition maximises the combination of theme and interest.

The intention was also to use these variables in the final scene and make Zee break the fourth wall by referring specifically to the viewer's guidance. In this instance, too, the production costs required a simplification, namely the provision of a smaller set of endings, responding in more general terms to the viewer's choices.

4.5 Delivery interfaces

The film was shown as an installation in a custom built display unit which contained 2 TFT screens with 1080p resolution. The larger 32" screen was placed at the back of the display unit, and showed the film's main narrative. The second screen, 27" in size, was housed face-down in the ceiling of the display unit and created a holographic reflection on a 2mm piece of glass, housed at 45° from the top back of the display to the bottom-front (a pseudo-holographic Pepper's Ghost display). It was used to display information pertaining to interaction points. Viewers initially interacted with the film using simple hand gestures via a LeapTM Motion controller, which was replaced, after some initial feedback with a standard mouse.

4.6 Exhibition

What is Love was presented at the 2018 York Mediale, an international biannual Media Arts Festival. It is to note that this was one year before *Bandersnatch* and *Click 1000* (see the "Interactive fictional stories" section). The setting for the exhibition was a 12th century, Grade 1 listed, Anglican church. In total, 6 viewing booths were constructed, each allowing a group of up to three people to simultaneously view the film. When watched in a group setting, a single person was asked to control the interactions.

The exhibition ran for a period of seven days, from 30 October to 6th November. During this period, more than 900 visitors experienced the interactive production. About mid-way through the exhibition, viewer feedback uncovered problems with the interaction interface (see above) as well as insufficient visual and aural signposting in some points of interaction. Both problems were fixed by correspondingly amending the production.

5 Evaluation

Three types of evaluations have been carried out: one by the Mediale team, reported in [55], and two by this research team, reported here: a questionnaire, to understand how aspects related to OBM narratives resonate with the general public, and interviews with the production team and three industry experts to analyse the form and the creation and production processes. Although the evaluation done by the Mediale team did not involve us, it is still worth mentioning that *What is Love?* received full marks for 8 out of 12 surveyed categories, including concept, captivation, distinctiveness, originality and excellence, making it one of the most appreciated exhibit of the festival [55].

5.1 Questionnaire

5.1.1 Aspects surveyed

Our survey comprised of nine questions (Q1-9), all responses being rated using a 5-point Likert scale from −2 (not at all / very poor) to +2 (fully / very good). The initial two questions asked respondents to rate their perceived interest in (Q1) and engagement with (Q2) the overall experience. Q3 assessed whether the interactivity added to, or detracted from, the film experience, and Q4 assessed the extent to which *What is Love?* had made the visitor interested in interactive narrative drama. The final five questions (Q5-9) related to the quality of individual aspects of the production: exhibition (Q5), story (Q6), aesthetics of moving picture and sound (Q7), acting (Q8) and interaction (Q9). Following this, two binary tick-box questions were provided, asking whether the visitor had experienced interactive TV or film narratives before and if they would be interested in seeing further examples of this form in the future. Finally, there was a space for any comments visitors wanted to feedback. The surveys were

kept completely anonymous, with respondents given only the option to provide their approximate age range (<30, 30−50, >50) and their occupation.

5.1.2 Data collection

Upon leaving the exhibition, random visitors were asked to complete a short survey. When the film had been viewed in a group, the viewer who had been in control of the interactions was asked to complete the feedback. We had 94 overall completed and valid questionnaires, and we use R to denote this number. Of the full set of respondents, r_1=46 experienced the exhibit before the interaction amendment (see section 4.6) and r_2=48 after. This sub-division, which is of almost equal sizing, allowed an informed analysis of the effect that the design alteration had upon the viewers experience.

In the following sections, we use $\bar{x}$ and $\tilde{x}$ to denote the mean and median, respectively. When significance is reported between the two sub groups, a comparison was calculated by using a Mann-Whitney U test. The limit for establishing a significance in the two datasets was defined as $p \leq 0.01$.

5.1.3 Summary of results

Figure 3 shows the distribution of respondents' feedback for each question. Two questions were rated positively ("good" or "very good") by 80% or more of the respondents – exhibition quality (Q5=83%) and aesthetic quality (Q7=80%). Three were rated positively by 70% or more respondents – interesting (Q2=79%), made you interested (Q4=77%) and acting quality (Q8=71%), with engagement and story quality and almost in the seventies (Q1=69%, Q6=69%). The only question that was positively by fewer people, but still over half of the respondents, was related to the value added by interactivity (Q3=54%). However, this was severely impacted upon by the inappropriateness of the interaction device and signposting, as the analysis below will illustrate. If we consider only the data after the iteration, when the problems were fixed (i.e. restricted to r_2), this question too, was evaluated positively by numbers approaching 70%.

For all the questions save two, the number of people evaluating positively – i.e. either "good" or "very good" – surpass the numbers giving lesser evaluations – i.e. "neutral", "poor", or "very poor". The exceptions are interactivity adding to the experience (Q3) and quality of interaction (Q9), which, even after the iterative fix, had the people evaluating as "neutral" surpassing those evaluating "very good" (but not those evaluating "good"). This indicates that interactivity remained the trickiest and weakest aspect of the production.

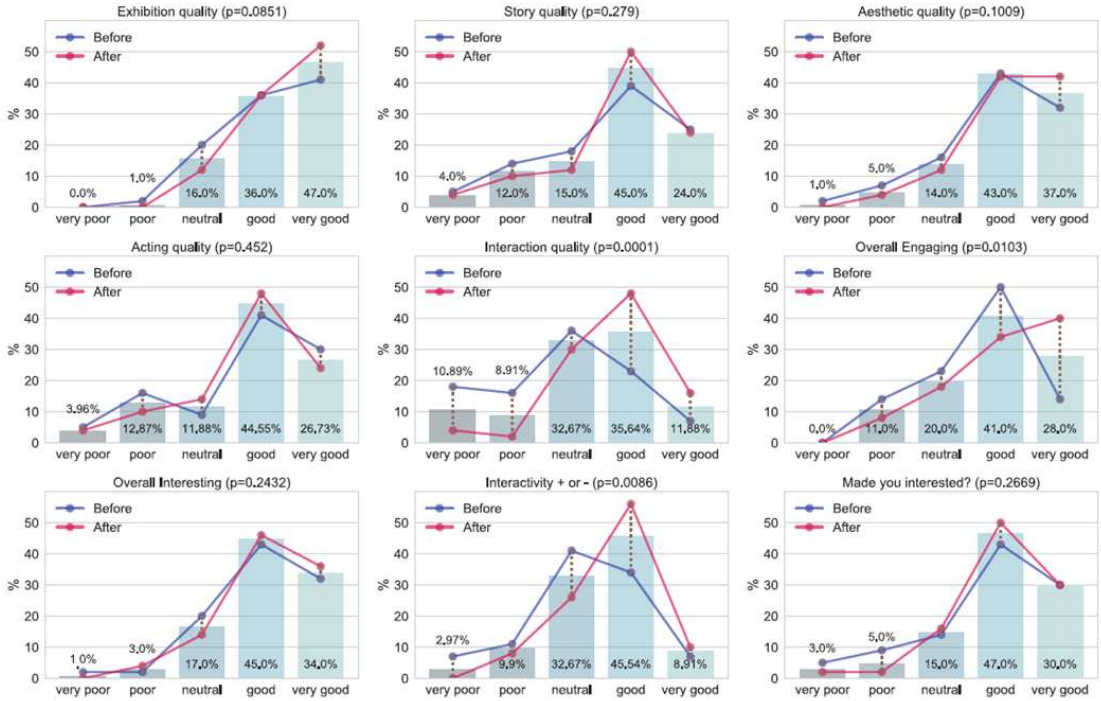

Figure 3: Distribution of questionnaire data (from left top to bottom right: Q5, 6, 7, 8, 9, 1, 2, 3, 4)

5.1.4 Overall experience and the value of interaction

Table 1 summarises respondents' feedback on Q1-4. Responses to Q1 and Q2 highlight that, overall, viewers found the experience to be both positively engaging (Q1, $\bar{R}$ = 0.862, $\tilde{R}$ = 1) and interesting (Q2, $\bar{R}$ = 1.074, $\tilde{R}$ = 1). There was a significant improvement in the overall rating of engagement (Q1) as a result of the change made midway through the exhibition ($\bar{r}_1$ = 0.64, $\bar{r}_2$= 1.06, p = 0.01), but not with regards to the overall interestingness. Q3, asking whether interactivity added to or detracted from the production, despite a positive evaluation (Q3, $\bar{R}$ = 0.46), received the lowest overall value. However, there is a significant improvement after the design iteration in the viewers' consideration that interactivity added value to the production ($\bar{r}_1$ = 0.23, $\bar{r}_2$= 0.68, p < 0.01). Q4, asking whether the production had made viewers interested in interactive dramatic narrative as a form of storytelling, received positive responses overall, but, also, saw no significant improvement after the iteration.

Table 1: (Q1-4) Engagement ratings, summary statistics

	$\bar{r}_1$	$\bar{r}_2$	$\bar{R}$	p
(Q1) Overall engaging	0.64	1.06	0.86	0.010
(Q2) Overall Interesting	1.00	1.14	1.07	0.243
(Q3) Interactivity + or -	0.23	0.68	0.47	0.008
(Q4) Made you interested?	0.84	1.04	0.95	0.266

5.1.5 Perceived quality

Table 2 summarises respondents' feedback on Q5-9, relating to the audience's perception of the quality of specific elements of the production. All areas were received positively by respondents (Q5-9, $\bar{R}$ > 0), the highest received being the quality of the exhibition ($\bar{R}$ = 1.29) and the lowest being the quality of the interaction (Q9, $\bar{R}$ = 0.30). However, it had a very significant improvement after the iteration ($\bar{r}_1$ = -0.16, $\bar{r}_2$= 0.70, p = 0.001), taking it form negative values to a value closer to 1. None of the other four questions (Q5-8) were significantly affected by the design iteration.

Table 2: (Q5-9) Quality ratings, summary statistics

	$\bar{r}_1$	$\bar{r}_2$	$\bar{R}$	p
(Q5) Exhibition	1.16	1.40	1.29	0.085
(Q6) Story	0.66	0.80	0.73	0.278
(Q7) Aesthetic	0.95	1.22	1.10	0.100
(Q8) Acting	0.75	0.78	0.77	0.452
(Q9) Interaction	-0.16	0.70	0.30	0.0001

5.2 Expert analysis

The production company, Symbolism, although experienced in very large budget film productions employing significant technological innovations, have found the production workflow of interactive film extremely challenging. Writing was the most difficult part of the process, posing a difficult challenge in solving two opposing requirements: providing a reason for the viewer to interact and allowing the story to flow naturally. For a traditional scriptwriter, narrative continuity seemed to invalidate the need for interaction, whilst the insertion of events that would motivate viewer interaction seemed to break the continuity of the narrative. Cutting Room helped, but was not sufficient to support an effective development of the script.

There was a divide between the intentions regarding the structure of the interactive narrative agreed in design workshops and the ones resulted after the content had was produced, which simplified significantly the design. This aspect uncovered the problems raised by this new form with regards to the production workflow. A more iterative development process was found to be necessary, but

difficult to implement, not least, due to the requirements for continuity. The abstract description of the footage might come naturally from experimenting with Cutting Room, but its realisation in production proved to be a difficult process. This uncovered the need for shooting grammars that allow a more flexible aggregation of content.

However, save all these problems, the production team became accustomed with the aggregation structures provided by Cutting Room and ended up describing *What is Love?* in the terms defined by our conceptual framework. Although the team did not achieve autonomy in using Cutting Room, they became comfortable users under our supervision and advice.

The key finding made with the production team as well as the industry experts regards the interaction mechanisms. Liking or disliking social media posts or providing emotional responses to them, indeed simple and meaningful, was concluded to be too simple as an interaction mechanism. In hindsight, everybody agreed that the overlay of social media with interactive storytelling, in story as well as viewer interaction, could indeed lead to a new form of interactive storytelling. The viewer should be made to believe they are one of Amelia's followers, and be given exactly the same interface for interaction as social media provides, via a secondary screen. The story employs social media in its plot and exposes it as a means of interaction to audiences. This concept appears to be very rich, as it could be used in individual viewing as well as social viewing. In the former case, interactions from other followers are staged. In the latter, they can be real communications between actual viewers, either in an asynchronous model, accumulating posts from prior individual viewings, or in a synchronous model, when all the viewers are watching at the same time.

Finally, the current short film developed here was found suitable to be the introduction of a longer movie. It prepares and surprises the viewer and illustrates the value of their interaction. The story could continue in earnest to take the viewer on a journey they can affect and explore.

6 DISCUSSION

All the key exemplar productions representing the state of the art, save *Accidental Lovers*, provide the viewer with binary choices which then determine the development of the story events. Through *What is Love?* we identified the potential for a more subtle and possibly more rewarding interaction – social media. The *potential* is demonstrated by *What is Love*, but it remains a hypothesis reached through the expert analysis.

What is Love? has been positively received by its viewers. This is encouraging, but we should consider that the positive evaluations might have been triggered by the (still) novelty of the paradigm. More refined evaluations are needed to really understand the public's position in this regard. Cutting Room provides the means for carrying out such experiments. Nevertheless, we have been able to make an insightful discovery with regards to how do we make interaction an intrinsic part of the story, rather than being a simple add-on. The use of social media in the story space as well as being exposed to the viewers.

The designs have been far more ambitious than what the final production illustrated. This, on one hand, illustrates the potential of Cutting Room to inform thinking, but, on the other, uncovers the need for more research into the understanding of the corresponding production workflows.

Despite a generous production budget, major simplifications to the story concept still had to be made to ensure its realisation. Various narrative structures that had been agreed at the design stage – e.g. increased pacing of storytelling to motivate interaction and developing the story along points of interest expressed indirectly through interaction – had to be discarded or severely simplified in the final implementation. This uncovers a major challenge in the development of this form: the provision of persuasive OBM exemplars to audiences.

7 CONCLUSION

This study, we hope, answers a number of fundamental questions. How do we conceive and think of non-linear story spaces that could result in meaningful and attractive linear story threads? What concepts, representations or structures could we employ to transform large stories spaces into comprehensible objects to the human mind? For this, we proposed a conceptual model dedicated to thinking of and designing OBM interactive fictional stories. Its recursive nature aims to allow creative producers to transform large stories spaces into comprehensible objects. How do we express our

thinking into something that the medium can operationalise itself? For this, we proposed Cutting Room, an authoring tool able to operationalise the structures of the conceptual model. How do we make interaction an intrinsic part of the story, rather than being a simple add-on? This we answered with a conjecture regarding the potential of integrating social media into the story as well as exposing it as a mechanism for interacting with the story.

We have presented an end-to-end study in authoring OBM fictional narrative experiences. We trust it constitutes a milestone in the development of OBM for fictional storytelling.

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